Risk Management in the Human Spaceflight Program

William Hoffman
NASA Johnson Space Center
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Agenda

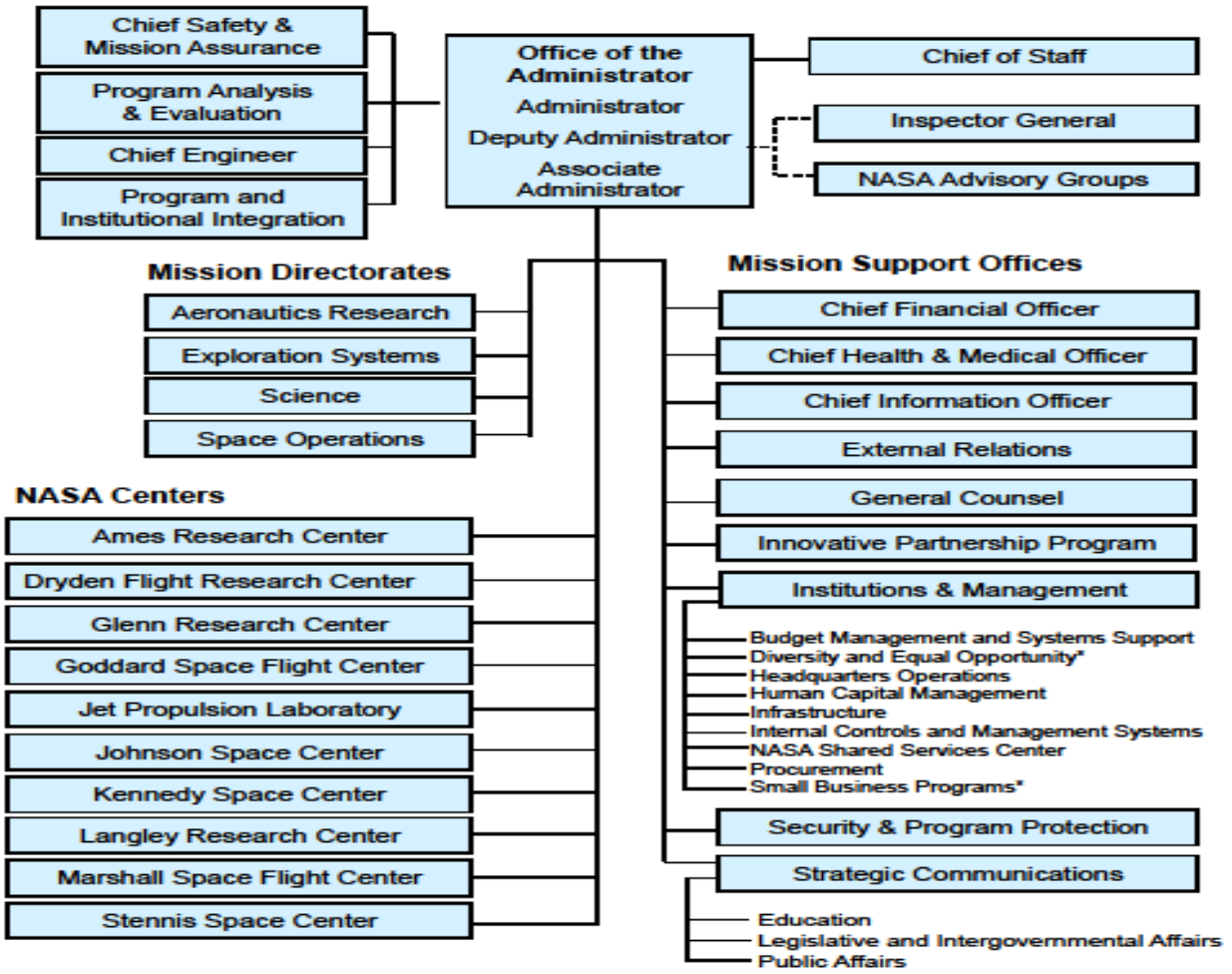
- NASA Mission and Organization - 5
- Major Mission Failures and Causes - 10
- Cultural Changes Resulting from Failures -10
- Safety at NASA Today - 5
- Best Safety Practices - 15
- Safety Challenges - 5
- Future Commitment - 5

NASA Space Act

- 1958 NASA Space Act created the Agency with aeronautical and space objectives including:

  (1) The expansion of human knowledge of the Earth and of phenomena in the atmosphere and space;
  (2) The improvement of the usefulness, performance,…. of aeronautical and space vehicles;
  (3) The development and operation of vehicles capable of carrying instruments,… and living organisms through space;……..
- The Act does not define organization: safety appears three times in document – dealing with liability and public safety

National Aeronautics and Space Administration



* In accordance with law or regulation, the offices of Diversity and Equal Opportunity and Small Business Programs maintain reporting relationships to the Administrator and Deputy Administrator.


UNITED STATES
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USA


APOLLO 11

NASA's Legacy Prior to Challenger

- Skylab
  - 1st US space station
  - 3 crew members
  - 3 missions, 29, 59, and 84 days
  - Experimental and observational platform

NASA's Legacy Prior to Challenger

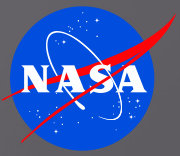
- Apollo-Soyuz
  - 1st international manned spaceflight
  - Test rendezvous and docking system compatibility
  - Opening for future manned spaceflights
  - 1975

Space Shuttle

Major Mission Failures

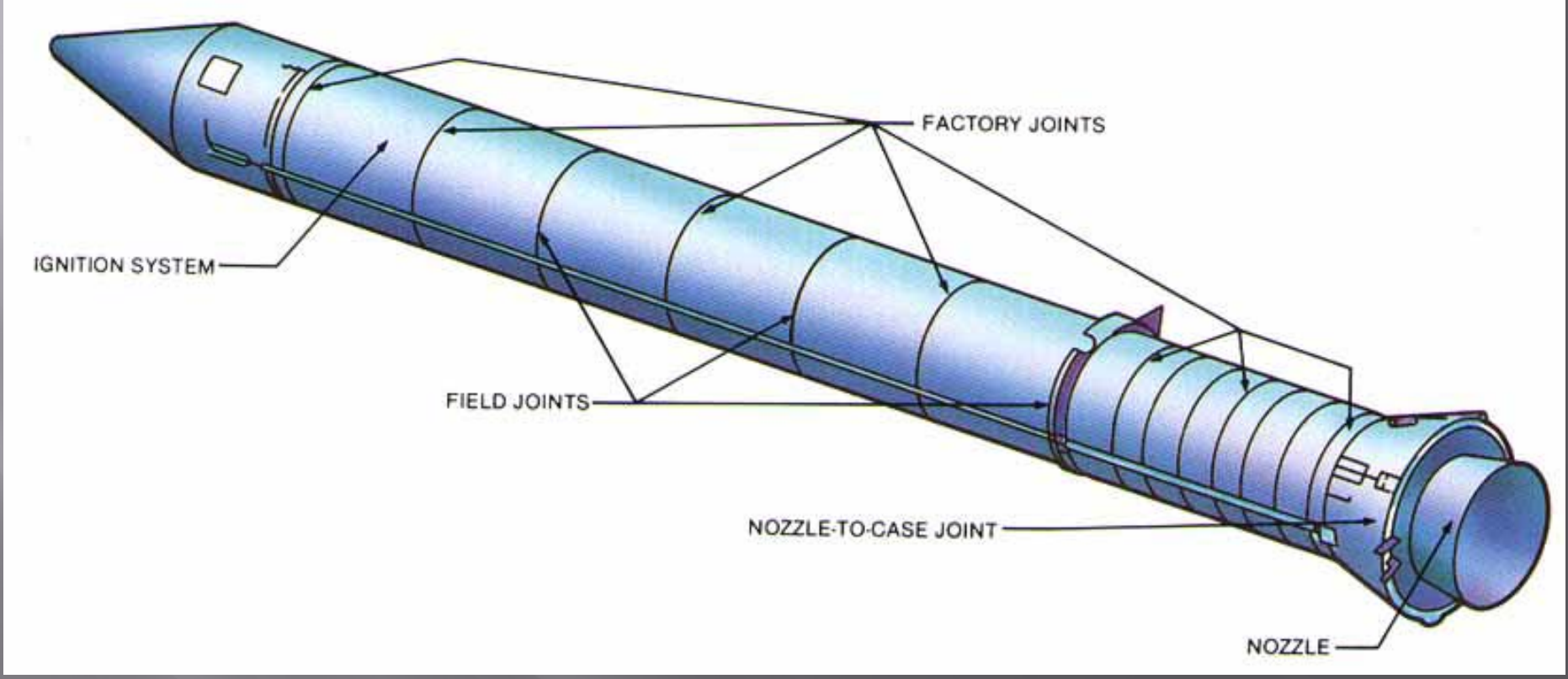
- Apollo 1
  - Capsule fire
  - Loss of 3 lives
  - Major redesign of capsule systems
- Challenger in 1986
  - Loss of seven crewmembers and national asset
  - Presidential commission chartered to determine root cause and recommend corrective actions to prevent recurrence
- Columbia in 2003
  - Loss of seven crewmembers and national asset
  - Agency administrator appointed investigation team to determine root cause and recommend actions to prevent recurrences

Findings and Root Causes of Challenger Investigation

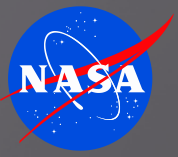


- Challenger root cause was burn through of o-ring at field joint exacerbated by cold ambient temperature
- Lack of engineering understanding of field joint performance over entire environmental operating range
- Stiffled communications paths between engineers and decision-makers
- Lack of closed loop problem reporting system elevating anomalous behavior to management
- Lack of an active safety program

Space Shuttle Solid Rocket Booster



Challenger Commission Contributing Cause Findings



- Decision making process seriously flawed leading up to launch of Challenger
- Waiving of launch constraints appeared to be at expense of flight safety and was not reviewed by all levels of management
- Marshall management appears to hold potentially serious problems internally

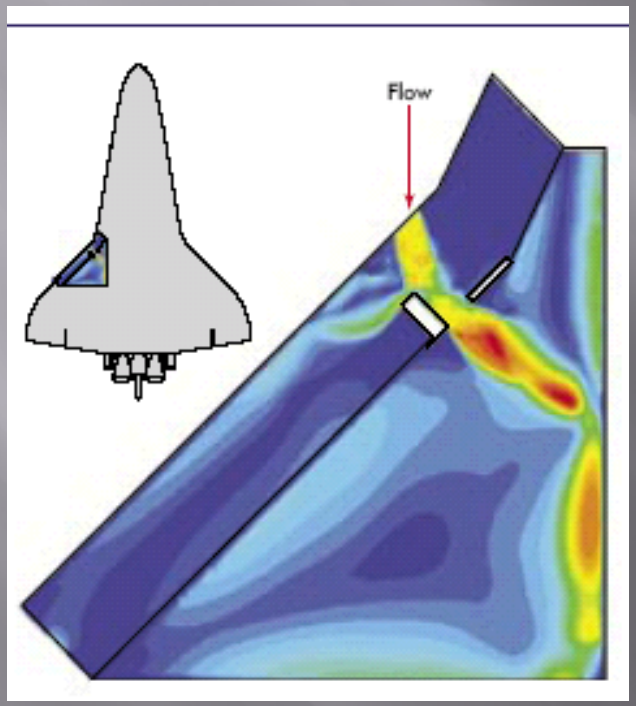
Challenger Commission Findings Accident Rooted in History

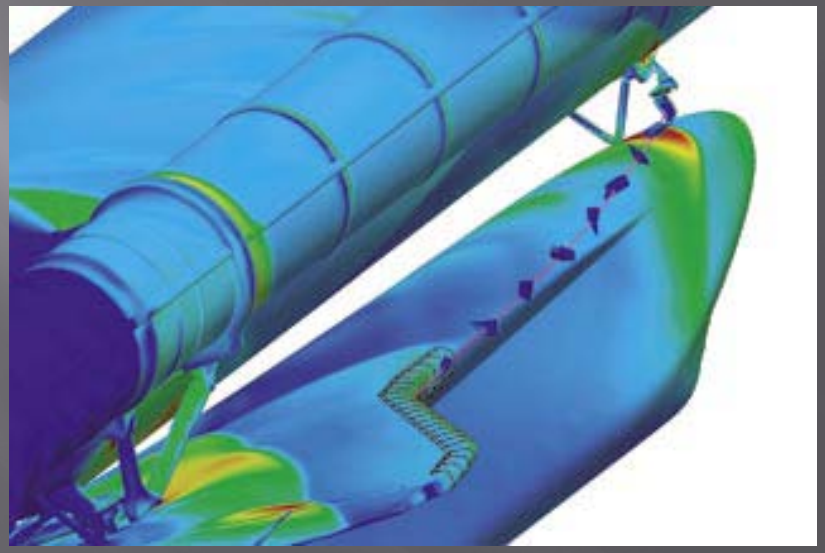
- Tracking of anomalies for Flight Readiness Reviews failed in not identifying joint seal failures on previous flights
- O-ring failure history presented to NASA Level I August 1985 was sufficient to require corrective action before next flight
- A careful flight history analysis would have revealed the correlation of O-ring damage with low temperatures

Challenger Commission Findings: Silent Safety Program

- Reductions in Marshall safety, reliability, and quality assurance work force limited capability in those functions
- Organization structures at Kennedy and Marshall place safety, reliability, and quality assurance offices under the offices whose activities they are to check
- Problem reporting requirements are not concise and fail to communicate to proper management

Columbia Accident



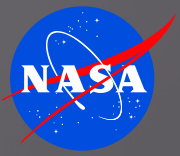


Columbia Accident Investigation Board Findings

"The physical cause of the loss of Columbia and its crew was a breach in the Thermal Protection System on the leading edge of the left wing."

"..the management practices overseeing the Space Shuttle Program were as much a cause of the accident as the foam that struck the left wing."

Findings and Root Causes of Columbia Investigation



- Loss of structural integrity of vehicle caused by hot gas ingestion due to external foam impact damage of Orbiter reinforced carbon-carbon leading edge
- Lack of fundamental understanding of hardware behavior over expected and observed environment
- Safety program was not strong
- Stifled communications between engineers and decision-makers
- Closed loop problem reporting system was not effective in identifying open safety issues

Challenger and Columbia Common Lessons Learned

- Provide continual and independent program oversight and program review functions that emphasize safety
- Ensure quality program and safety management that have clear definition of authority and responsibility and have resources commensurate with requirements
- Maintain comprehensive and effective program processes and systems that support the safety risk management function.

Challenger and Columbia Common Lessons Learned

- Maintain realistic plans that have provisions for flexibility, minimize outside pressures, and stress flight and ground safety
- Control effectively the development of critical items with respect to performance environments, tolerances, margins, manufacturing processes, testing, and safety

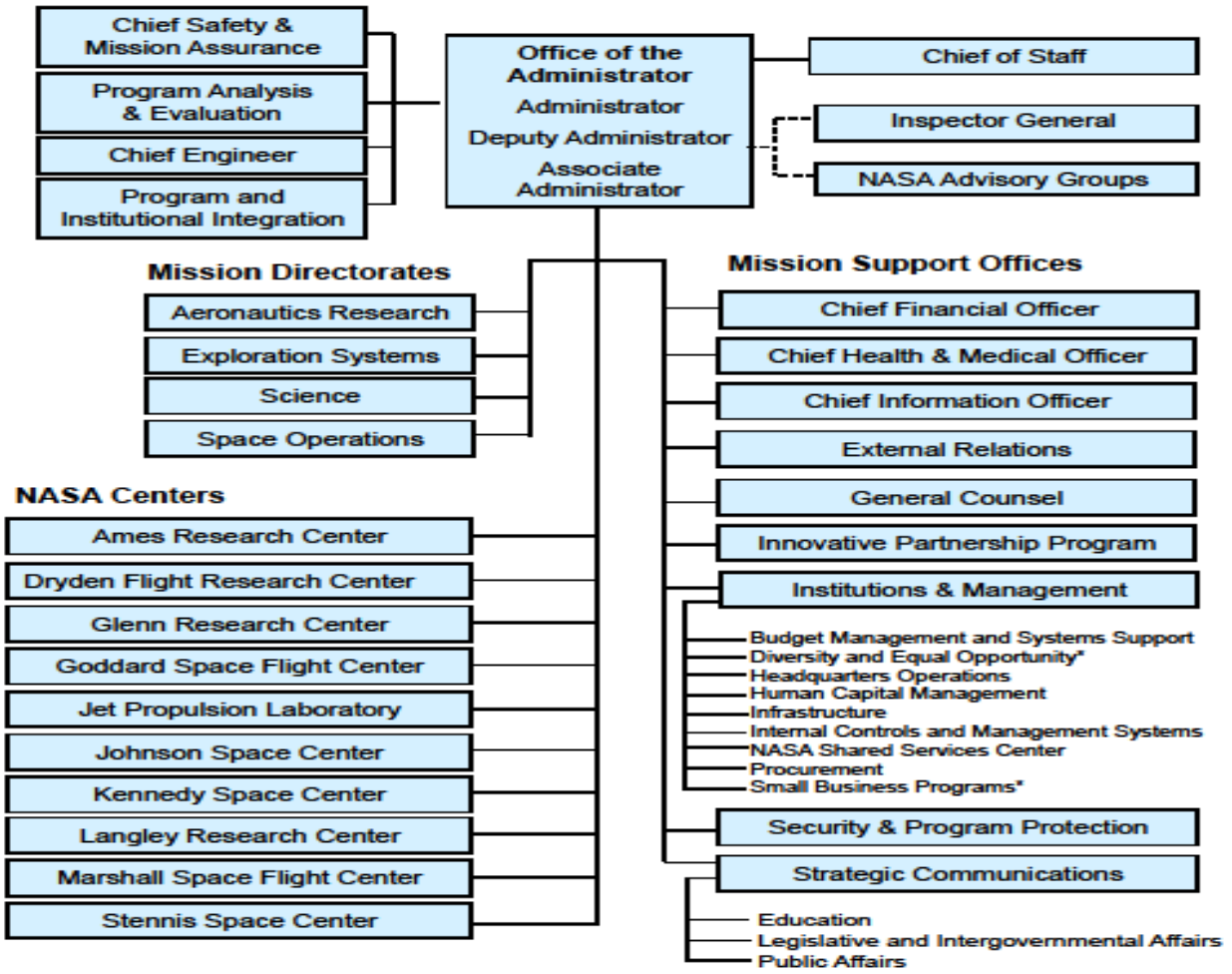
Challenger and Columbia Common Lessons Learned

- Ensure quality performance of work force involved in safety critical operations including adherence to required procedures and constraints
- Provide cultural climate conducive to expression of differing opinions and open dialog

Changes Resulting From Challenger and Columbia

- Institution of Headquarters level Office of Safety and Mission Assurance with vote at flight readiness assessments
- Strengthened problem reporting processes
- Safety organizations grew to provide deeper support to projects and independent assessment of issues
- Safety reporting avenues increased
  - National Safety Reporting System
  - NASA Safety Hotline

National Aeronautics and Space Administration



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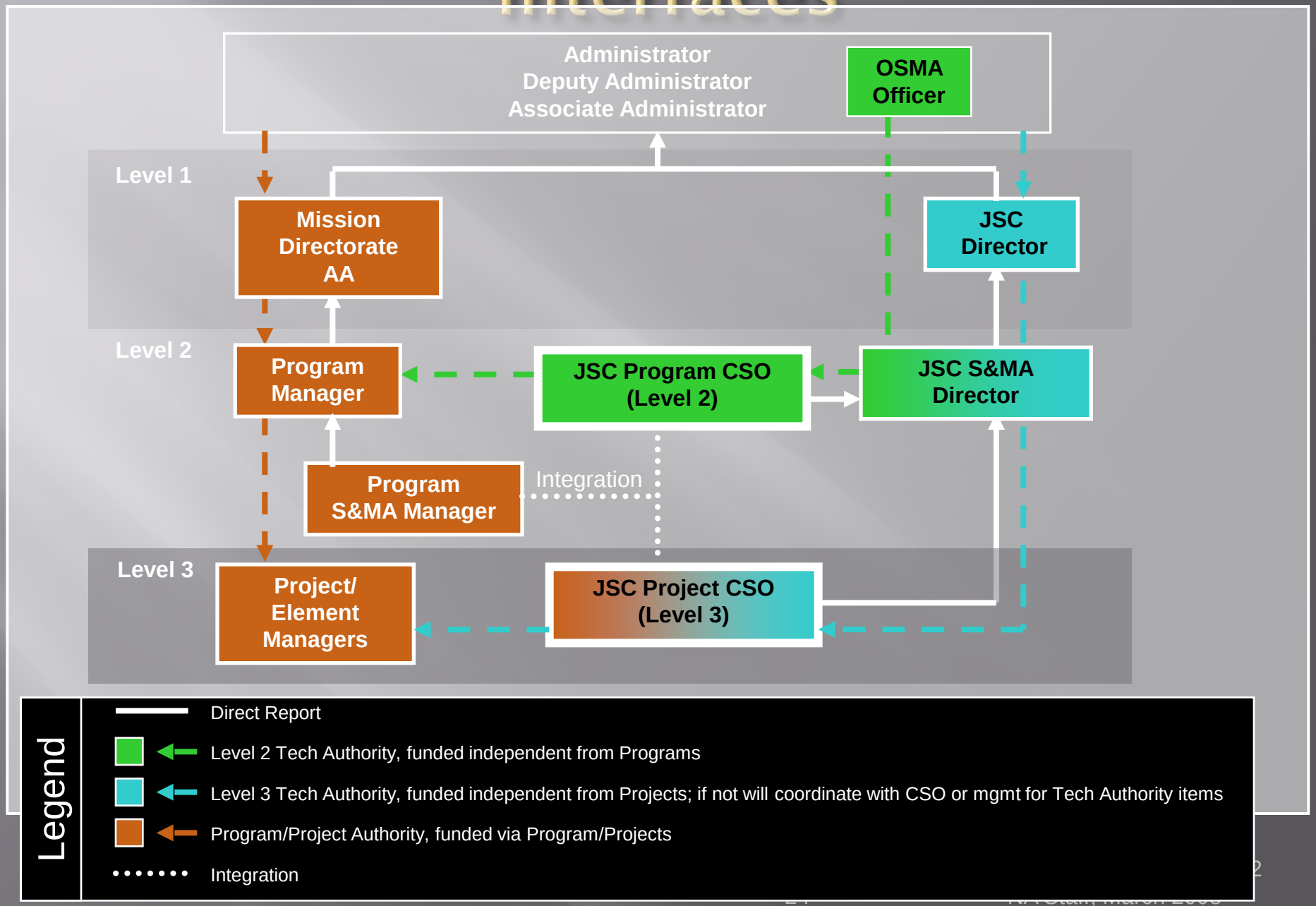
Improvements in Flight and Institutional Safety Approach

- Technical authority responsibilities strengthened
  - Voting role for Engineering and Safety in decision process
- Information flow to decision makers
  - Dissenting opinion process formalized
- Numerous options to report employee concerns
- Leadership expectations are communicated/reinforced through actions

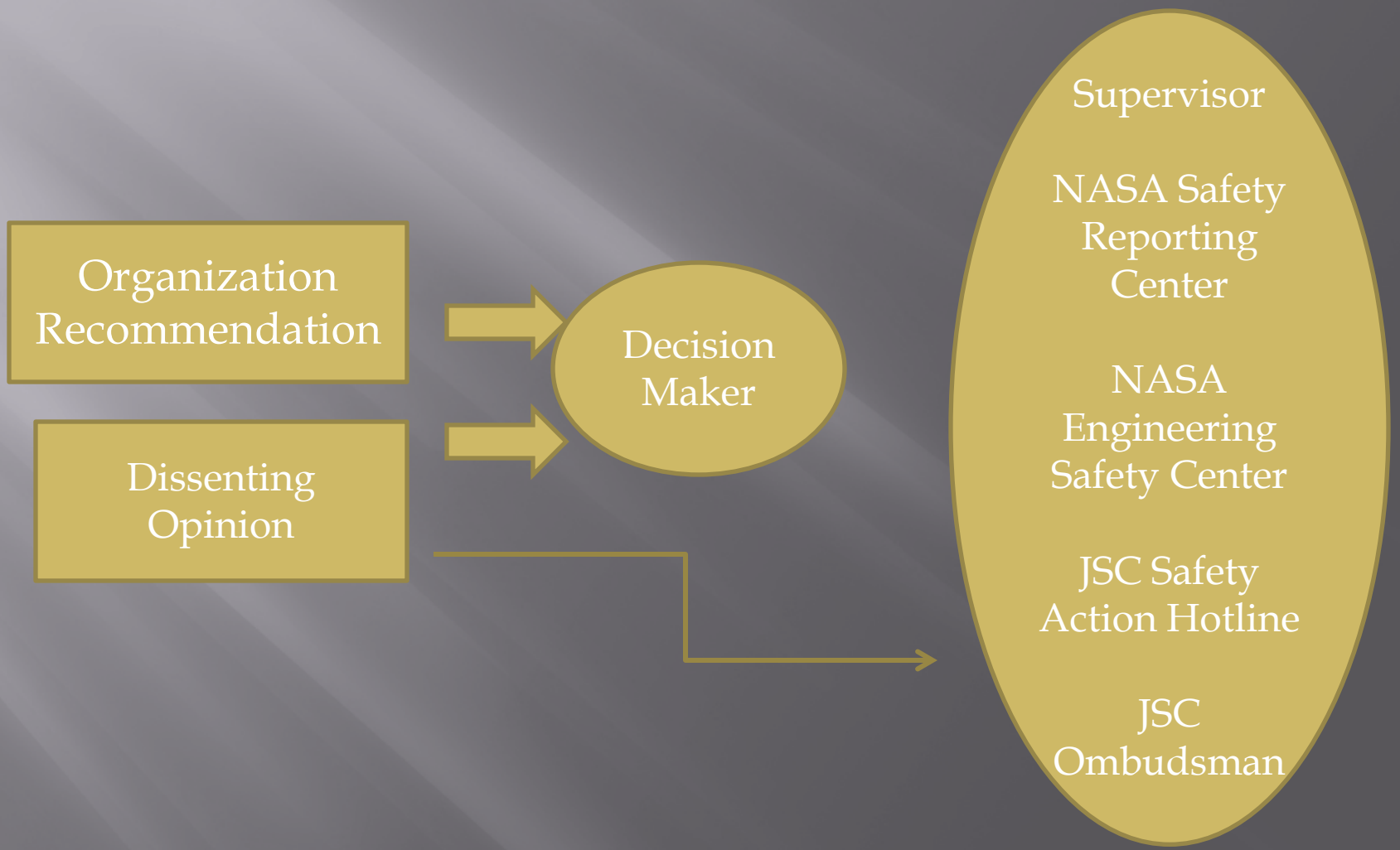
Overview – Program/Project Interfaces



Safety at NASA Today

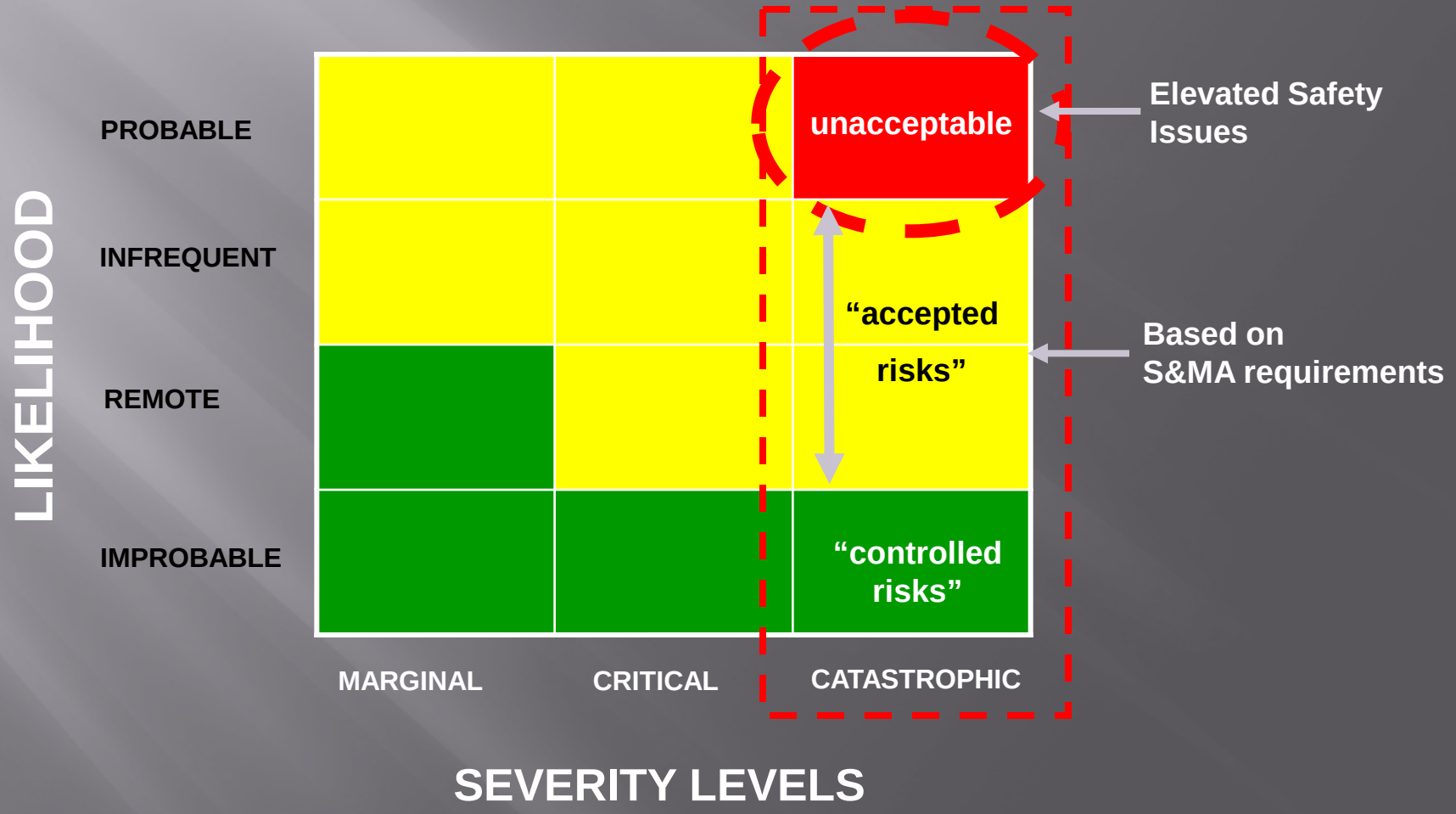
- Expectation is that personnel speak up and address safety issues
- Management expectation of supporting individuals who voice dissenting opinion in project decision forums, technical dissenting opinions are actively solicited
- Effort to draw out individuals who are not normally outgoing in public forums
- Intimidation, exclusion, squelching, ignoring of safety input is not tolerated
- Risks are assessed using a hazard frequency-consequence template – provides common language for risk discussion

Dissenting Opinion Process



Risk Management Process

An Example of the Main Area of Risk for OSMA/Governance Focus



Best Safety Practices

- Safety Boards address safety concerns/issues with project items
  - Flight equipment safety review panel
  - Space Station/Space Shuttle Safety Review Panel
- Boards are chaired by safety office with membership consisting of engineering, project, safety professionals
- Boards are integral to flight review process

Best Safety Practices

- JSC is an OSHA VPP Star Site
  - Monitoring and continually improving performance
- Effective safety enhancement practices
  - Weekly management safety walk-arounds weekly
  - Close call reports to heighten awareness of issues
  - Safety Briefings begin each organizational staff meeting
    - Review issues from past week
    - Safety topics discussed to share lessons learned across organization
    - Safety topics discussed with employees in staff meetings

Safety Practices

- JSC holds annual safety and total health day dedicated to addressing safety in the workplace and mission safety
  - Work stand down to address job safety training, address open safety issues, and participate in safety presentations on organizational/home safety concerns
- Safety is part of individual job performance and is part of evaluation

Safety & Health Goals for 2009

Leadership

Continue to encourage safe behaviors, attitudes, and employee involvement.

MEASURES:

- *S&H Topic Participation*
- *S&H Forum Participation*
- *JSC Safety Action Team Sponsorship*

Prevention

Improve employee participation in prevention activities.

MEASURES:

- *S&H Training Delivery*
- *Close Call Submission & Acceptance*
- *Building Inspection*

Reaction

Reduce mishaps and improve investigation response.

MEASURES:

- *Mishap Rate vs. Industry vs. NASA Target*
- *Event Rate Performance*
- *Mishap Timeliness Metric*

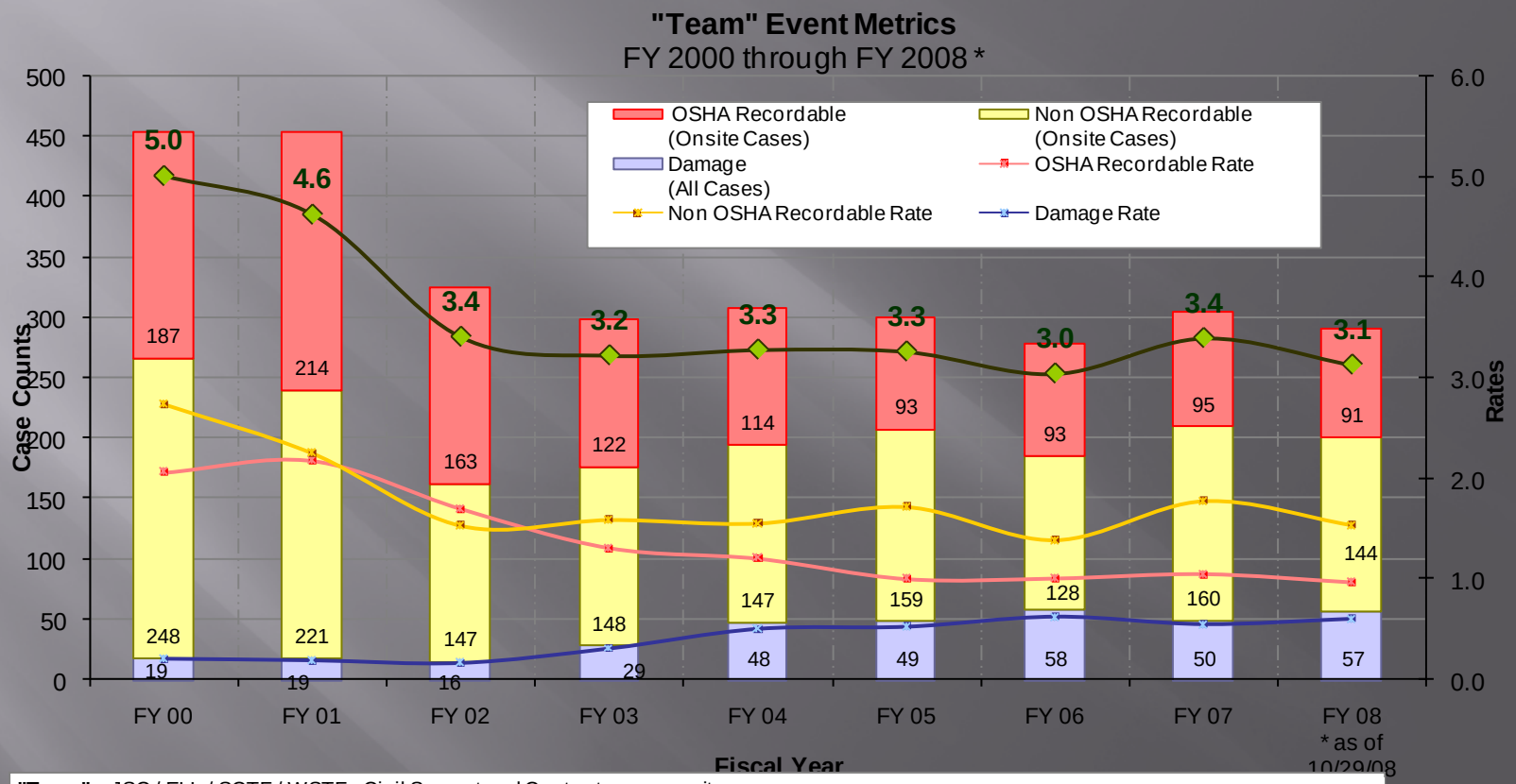
Issue Resolution

Assure response to challenges reflect thoughtful approach to risk mitigation.

MEASURES:

- *Minimized Issue Impact*
- *Feedback on Issue Response*
- *Effectiveness of Corrective Actions*

Reaction – Event Metric

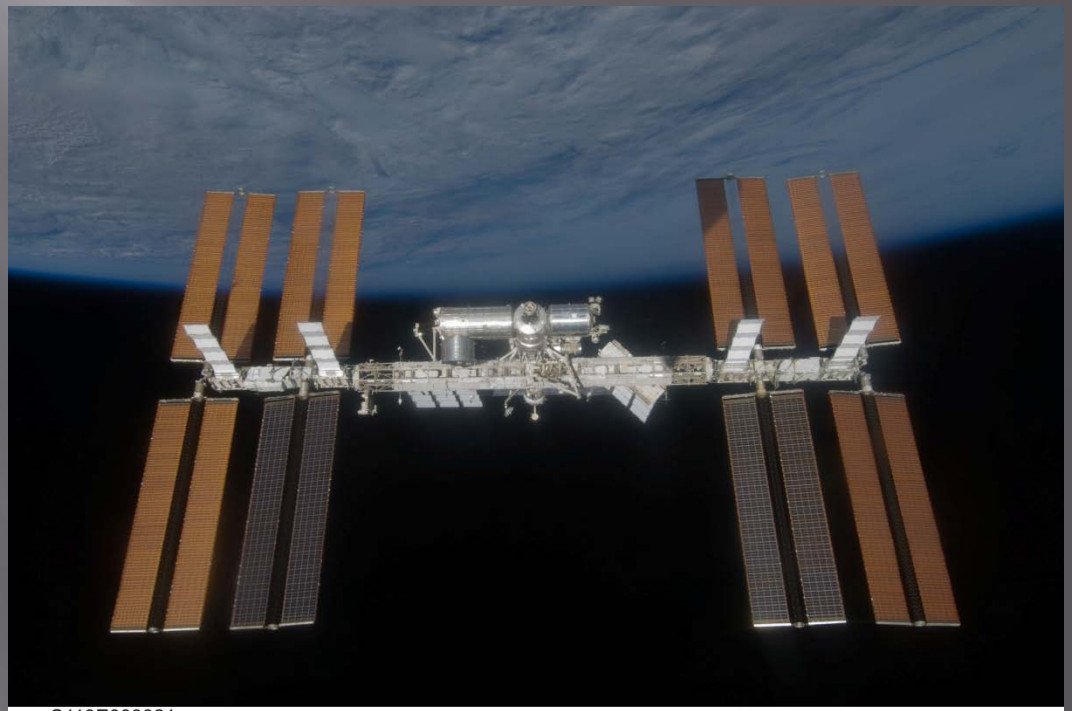


"Team" = JSC / ELL / SCTF / WSTF - Civil Servant and Contractor community
OSHA Recordables = Death, Days Away, Restricted, Medical Treatment, and OSHA Illness
Non OSHA Recordable = First Aids, Non-OSHA Illness, and No Treatments (Reportable cases per JPR 1700.1)
Damages = Equipment or Property regardless of $ value

Rates = (Cases * 200,000) / Hours

Space Shuttle

International Space Station



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Constellation Program Elements for Exploration

Ares V

Ares I

Orion